

Electrolytic Actuators:
Exploring New Directions in Electrical–Mechanical
Energy Transduction

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Microelectromechanical systems and sensors continue to show interesting potential application in emerging technologies. One condition which could limit their usefulness is the effective transduction of applied energy to mechanical work in the microscopic domain; this drives the search for new microactuators.

Previous efforts have included systems based on electrochemical processes. For example, numerous bimorph actuators that exploit differential swelling in conducting polymers[1] have been demonstrated. These can be troublesome in that they exhibit relatively small deflections, have limited geometric applicability, are typically slow and generally require problematic electrolyte encapsulation schemes. Actuators based on carbon nanotubes[2] and mercury electrocapillary action[3] are also known. These devices are driven by interfacial capacitance, and are therefore limited by surface area.

This investigation explores new modes of mechanical actuation based on electrolytic cycles. This marks an important departure from more traditional actuation strategies such as those based on magnetic or electrostatic mechanisms, and it offers a number of key advantages over other methods.

Electrolytic actuation can be achieved using well known chemically reversible electrochemical processes. This is particularly advantageous in that electrical parameters associated with the process (e.g., controlled current or coulometry) can provide a simple and precise means of controlling the actuator motion and monitoring its status. The relatively low voltage requirements of electrolytic reactions obviate the need for complicated ancillary systems.

Furthermore, an actuator based on the electrolytic motif offers the advantage of low power consumption. The simplicity of the design lends itself well to scaling for application–specific requirements. The low mass of the devices is also attractive for weight–critical applications, and should provide larger transformations per unit mass than other electrochemical systems.

Electrolytic actuators offer promise in overcoming difficulties associated with conventional actuators, e.g., weight and lower limits on scalability. This presentation will discuss some of our prototype electrolytic actuator designs.

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